Pleistocene Margin Stratigraphy, New Jersey vs. Northern California: A STRATAFORM Study of Contrasts

Gregory Mountain (P.I.)
Lamont-Doherty Earth Observatory of Columbia University
Palisades, NY 10964-8000
phone: (914) 365-8540 fax: (914) 365-3181 email: mountain@ldeo.columbia.edu
Peter Buhl (Co-P.I.)
Lamont-Doherty Earth Observatory of Columbia University
Palisades, NY 10964-8000
phone: (914) 365-8527 fax: (914) 365-3181 email: buhl@ldeo.columbia.edu
Award Number: N00014-96-1-0377
http://ldeo.columbia.edu

LONG-TERM GOALS

The goal of STRATAFORM is to link short-term biological and physical processes affecting sedimentation ("event" stratigraphy" developed over hours to weeks) to the stratigraphic geometry and facies distribution of the upper ~100 m of continental margin sediments representing ~10^6 years of preserved record.

OBJECTIVES

Three groups of processes have been isolated for study by STRATAFORM investigators: 1) shelf sediment dynamics and the development of lithostratigraphy; 2) slope processes and their role in shaping geomorphology; and 3) stratigraphic sequence generation. Collecting high-resolution seismic reflection data as we have done is at the core of this third approach. All three are linked by our goal of determining how the morphology and facies patterns of the modern sea floor (revealed by multibeam bathymetry, backscatter data, and sampling of the shelf and slope) compare with the preserved geologic record observed in seismic images and sampled in the subsurface.

APPROACH

With funding from ONR and other sources, Lamont-Doherty assembled equipment to meet the STRATAFORM requirements of high-resolution reflection profiling. This included a generator-injector ("GI") airgun, towing harness, and shot control system, a 2000 psi diesel-powered compressor, a 48-channel 600-m narrow-gauge (solid, not oil-filled) analog streamer with depth-control birds, and a digital recording system capable of the moderately high sampling rates (0.5 msec) required for ~5m vertical resolution of sub-seafloor images. Existing profiles showed that a track spacing of 2 to 5 km on the New Jersey margin was sufficient to map the comparatively uniform stratigraphy of that passive margin; a 950 nm survey was completed on cruise Oc270 in July, 1995. Structural complexities off northern California, by contrast, required line spacing of 800 m and less; a 1200 nm grid on cruise W9605 was completed in July, 1997. Both seismic surveys were designed to: cover areas previously mapped with swath bathymetry and acoustic backscatter; tie to available seafloor samples; and duplicate several profiles of lower resolution (air gun) and higher resolution (Huntec) imaging. This

Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
30 SEP 1999		**00-00-1999 to 00-00-1999**

4. TITLE AND SUBTITLE	5a. CONTRACT NUMBER
Pleistocene Margin Stratigraphy, New Jersey vs. Northern California: A STRATAFORM Study of Contrasts	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **Columbia University,Lamont-Doherty Earth Observatory,Palisades,NY,10964**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

13. SUPPLEMENTARY NOTES

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			
unclassified	**unclassified**	**unclassified**	**Same as Report (SAR)**	**4**	

"nested" data set allowed us to optimize the information provided by each acquisition system and provide a more complete understanding of processes shaping the geologic record along both continental margins.

WORK COMPLETED

It was agreed at the start of this project that teams of investigators at L-DEO and UTIG would split all processing tasks equally, and that completed SEG-Y stack files would be exchanged. All Oc270 seismic profiles have been processed and exchanged between institutions, and each now has a complete set of stacked, mostly all migrated, SEG-Y files. Both institutions are on their own to prepare these as displays on paper and/or on seismic workstations. At L-DEO we have begun reformatting these data onto disk for mapping with our Landmark 'SeisWorks' package. Extra care in terms of velocity analysis and display parameters have been applied to the dozen or so profiles that link the outer shelf / upper slope grid of lines encompassing the ODP Leg 174A drillsites 1071, 1072, and 1073. Core and downhole log measurements relevant to integration with the seismic data and to understanding the stratigraphic histories of these sites have been prepared to aid correlation between all data types. This has involved applying 'check-shot' survey data acquired at the ODP drillsites, thereby providing conversion of depth-below-seafloor data to travel-time-below seafloor data to match the seismic presentation. Intriguing relationships between seismic stratal geometries, log character, sediment composition, and chronostratigraphy have been revealed and reported at STRATAFORM and other national science meetings.

Regarding the northern California data set, unwanted noise that we believe originated in electronic crosstalk from the 'birds' that control the depth of the streamer has been detected in the W9605 data. At L-DEO we are evaluating various techniques designed to minimize or totally eliminate this noise before declaring that the data are processed to our satisfaction and are sent to our colleagues in Austin. We intend to make isopach and structural contour maps of key sub-seafloor reflectors along both margins. Because only the Oc270 can thus far be tied to subseafloor samples, correlations to the rock record are currently restricted to the New Jersey margin.

In preparation for deep sampling offshore northern California, a report and oral presentation was made to the JOIDES Pollution Prevention and Safety Panel. While a sampling program conducted with ONR support would not be obliged to pass JOIDES review, it was thought prudent to consult the advice of this group of experts. There is evidence for considerable amounts of shallow gas in both the shelf and slope sediments of the Eel River Basin, and callous deep sampling could pose a safety, pollution, and political hazard that we must avoid.

RESULTS

The grid of Oc270 profiles show that Pleistocene sediments along the outermost New Jersey shelf accumulated in 4 major units that vary from several tens to hundreds of meters in thickness. Reflectors marking the boundaries between these units have been traced to the slope and across Site 1073 in 639 m of water. Unusually good age control (based on ∂O^{18} measurements and tied to various datum levels, all provided by colleagues, and then tuned to the global SPECMAP curve) yields precision to the sub-stage (ca. 5-20 ka) level for the entire 520 m and 660 ka section. Seismic-log-core correlations show the boundaries between these units are marked by distinct reflecting surfaces that resulted from slope sediment starvation during times of rapid eustatic rise when deposition became concentrated on a

wide and flooded continental shelf. By contrast, weakly reflective sediments blanketed the mid-slope from highstand through early fall as the depocenter moved seaward to the outer shelf. These reflectors are typically overlain by chaotic, discontinuous reflections related to mass-transport deposits that covered the paleoshelf edge to uppermost slope approaching times of maximum lowstand; coeval packages of distinct and continuous reflections developed farther downslope where the fine-grained fraction of these mass-transport units settled out. With this extraordinarily good age control, we are now able to trace chronostratigraphic surfaces back up to the shelf and infer links between stratal architecture and the processes that shaped it. This analysis of sequence development has not been possible before now because of the scarce sample control provided by existing drill cores.

This importance of sub-seafloor samples providing ground-truth for our seismic data remains equally apparent offshore northern California. Thus far only box cores and short piston cores have be collected. The JOIDES Pollution Prevention and Safety Panel reviewed the report presented them, and determined that none of the proposed sites of long (~ 50 m) piston coring posed a concern; in their judgment, any sediment into which a piston core could penetrate would not be sufficiently competent to form a seal and maintain elevated gas or fluid pressures. However, drilling by the PROD to practically any depth posed more of a concern, and they asked that when we had a more mature PROD drilling plan prepared that we return with a more substantial report.

IMPACT / APPLICATIONS

These findings show that in contrast to earlier research that has focused on shallow-water facies of siliciclastic shelves, the slope can provide a surprisingly complete and discernible record of events that has been removed from, or has not yet been documented in, studies of shallow-water shelves. By tracing surfaces from this relatively complete slope record we are now able to identify elements of the stratal architecture beneath the shelf that can be interpreted in a eustatic context. Due to severe offlapping patterns implying sediment by-pass or shelf erosion, previous efforts to derive this history based only on samples from the shelf was totally impossible.

TRANSITIONS

Maps of sediment thickness and structural features off both New Jersey and northern California will be made available to all STRATAFORM investigators. We have matched these data to other acoustic records (HUNTEC, lower resolution airgun profiles, etc.) and have developed a coring strategy to ground-truth these data and address the primary STRATAFORM issue of how well the event-scale features of the seafloor are preserved in the geologic record.

RELATED PROJECTS

STRATAFORM investigators are in regular communication, pursuing parallel and complementary studies. Data will be exchanged between all investigators when complete. For example, M.Field and colleagues (USGS) have a similar project evaluating finer-scale histories of sediment geometries off Eel River using Huntec technology; J.Austin and colleagues (UTIG) are doing similar interpretations of HUNTEC data off New Jersey. The combination of Hi-Res MCS data along overlapping track lines on both margins will provide a unique and valuable assessment of sediment processes at a wide range of scales. M. Steckler (L-DEO) and colleagues are modeling depositional geometries on both margins, and profiles developed in this project will provide them with valuable ground truth. We anticipate

especially unique insights to be gained by incorporating the effects of Pleistocene ice loading on the New Jersey margin J.Goff (UTIG) and colleagues have prepared a seabed backscatter map on both margins and will be examining correlations between their findings and sub-bottom facies and structure that our profiles reveal. James Syvitski (Colorado) and colleagues are examining factors that destabilize slope sediments, and the history of mass wasting revealed by our profiles will be a valuable long-term record.

PUBLICATIONS

Fulthorpe, C.S., J.A. Austin, and G.S. Mountain, submitted, Morphology and distribution of Miocene slope incision on the New Jersey continental margin, *Geol. Soc. America Bull.*

Mountain, G.S., J.A. Austin, Jr., and C. Alexander, 1999, Proposed Coring in the Eel River Basin Offshore Eureka, California, Hazard Assessment Report to the JOIDES Pollution Prevention and Safety Panel, April 15.

Fulthorpe, C.S., J.A. Austin, and G.S. Mountain, 1999, Buried fluvial channels on the New Jersey continental margin: Did sea-level lowstands expose the entire shelf during the Miocene?, *Geology* 27(3):203-206.

Steckler, M.S., G.S. Mountain, K.G. Miller, and N.Christie-Blick, 1999, Reconstructing the geometry of Tertiary sequences on the New Jersey passive margin by 2-D backstripping: the interplay of sedimentation, eustasy and climate, *Marine Geology* 154:399-420.

Miller, K.G., G.S. Mountain, J.S. Browning, M. Kominz, P.J. Sugarman, N. Christie-Blick, M.E. Katz, and J.D. Wright, 1998, Cenozoic global sea level, sequences, and the New Jersey transect: results from coastal plain and continental slope drilling, *Reviews of Geophysics* 36(4):569-601.